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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Daniel P. Johnson

Title: GLOBAL EQUATION SOLVER AND OPTIMIZER

Docket No.: H0002678.34215	Serial No.: 10/032,682
Filed: December 28, 2001	Due Date: December 20, 2006
Examiner: Susanna Meinecke-Diaz	Group Art Unit: 3623

MS Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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(GENERAL)

APPEAL BRIEF UNDER 37 C.F.R. § 41.37

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For: GLOBAL EQUATION SOLVER AND OPTIMIZER

APPEAL BRIEF UNDER 37 CFR § 41.37

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Commissioner for Patents
P.O. Box 1450
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Sir:

The Appeal Brief is presented in support of the Notice of Appeal to the Board of Patent Appeals and Interferences, filed on October 19, 2006, from the Final Rejection of claims 1-20 of the above-identified application, as set forth in the Final Office Action mailed on July 20, 2006.

The Commissioner of Patents and Trademarks is hereby authorized to charge Deposit Account No. 19-0743 in the amount of $500.00 which represents the requisite fee set forth in 37 C.F.R. § 41.20(b)(2). The Appellant respectfully requests consideration and reversal of the Examiner's rejections of pending claims.

1. REAL PARTY IN INTEREST

The real party in interest of the above-captioned patent application is the assignee, HONEYWELL INC..

2. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to Appellant that will have a bearing on the Board's decision in the present appeal.

3. STATUS OF THE CLAIMS

The present application was filed on December 28, 2001 with claims 1-20. A non-final Office Action was mailed on January 30, 2006. In response, the Applicant amended the claims. A Final Office Action was mailed on July 20, 2006. Claims 1-20 stand twice rejected, remain pending, and are the subject of the present Appeal.

4. STATUS OF AMENDMENTS

No amendments have been made subsequent to the Final Office Action dated July 20, 2006.

5. SUMMARY OF CLAIMED SUBJECT MATTER

Some aspects of the present inventive subject matter include, but are not limited to, the solving of operations problems.

In an embodiment, a method solves an operations problem. (p. 7, ll. 21-22; FIG. 3, No. 300). The operations problem may relate to a scheduling problem in a particular business operation. (p. 5, ll. 1-3; p. 7, ll. 25-27). Variables, relationships, and constraints relating to the scheduling problem are received. (p. 7, ll. 27-28; FIG. 3, Nos. 302, 304, 306). A set of non-convex quadratic equations, based on the variables, relationships, and constraints are formed. (p. 8, ll. 7-8; FIG. 3, No. 308). The set of non-convex quadratic equations are then solved by applying a bound propagation process, a local linear bounding process, a local linearization process, and a global subdivision search. (p. 8, ll. 21-23; FIG. 3, No. 310). Finally, it is determined whether a solution to the scheduling problem is optimal, feasible, or infeasible. (p. 8, ll. 25-26; FIG. 3, No. 310).

In another embodiment, a machine-accessible medium has associated therewith content capable of directing the machine to perform a method of solving a set of non-convex quadratic equations relating to a scheduling problem in a particular business operation. (p. 10, ll. 6-8; FIG. 4, No. 400). In the method, a region bounding all variables relating to the scheduling problem is selected. (p. 10, ll. 8-10; FIG. 4, No. 412). A bound propagation process is applied to the region to refine the bounds and improve linearization. (p. 10, ll. 10-11; FIG. 4, No. 402). A local linear bounding process is applied to the region to determine feasibility and to find approximately feasible solutions to the scheduling problem. (p. 10, ll. 11-12). A local linearization process is applied to the region to determine feasibility and local optimality. (p. 10, ll. 18-19; FIG. 4, No. 404). Upon finding an optimal global solution to the scheduling problem, the optimal global solution and information indicating optimality is provided. (p. 10, ll. 21-23; FIG. 4, Nos. 414, 418, 424, 426). Upon finding a feasible global solution to the scheduling problem, providing the feasible global solution to the scheduling problem and information indicating feasibility. (p. 10, ll. 23-25; FIG. 4, No. 430). Upon determining local infeasibility, eliminating the region from consideration. (p. 10, ll. 25-26; FIG. 4, No. 432). Upon determining global infeasibility, providing information indicating infeasibility. (p. 10, ll. 26-27; FIG. 4, No. 432). Finally, upon

not finding a solution to the scheduling problem, a global subdivision search is applied to the region to produce two or more regions. Additionally, the bound propagation, local linear bounding, and local linearization processes are iteratively applied to each of the two or more regions until it is determined whether the solution to the scheduling problem is optimal, feasible, or infeasible. (p. 10, l. 27 – p. 11, l. 3).

In another embodiment, a set of non-convex quadratic equations relating to a scheduling problem in a particular business operation is solved. (p. 11, ll. 12-13; FIG. 4, No. 400). A region bounding all variables relating to the scheduling problem is selected. (p. 11, ll. 13-14; FIG. 4, No. 412). A bound propagation process is applied to the region to refine the bounds and improve linearization. (p. 11, ll. 14-15; FIG. 4, No. 402). A local linear bounding process is applied to the region to determine feasibility and to find approximately feasible solutions to the scheduling problem. (p. 11, ll. 15-17; FIG. 4, No. 404). A local linearization process is applied to the region to determine feasibility and local optimality. (p. 11, ll. 17-18; FIG. 4, No. 406). Upon finding a solution to the scheduling problem after the local linearization process, the solution is provided. (p. 18-19; FIG. 4, Nos. 422, 426). Upon determining infeasibility, the region is eliminated from consideration. (p. 11, ll. 19-20; FIG. 4, No. 432). Upon not finding the solution to the scheduling problem after the local linearization process, a global subdivision search is applied to the region to produce two or more regions, and the bound propagation, local linear bounding, and local linearization processes are iteratively applied to each of the two or more regions until it is determined whether the solution to the scheduling problem is optimal, feasible, or infeasible. (p. 11, ll. 20-25; Fig. 4, Nos. 422, 408).

This summary does not provide an exhaustive or exclusive view of the present subject matter, and Appellant refers to the appended claims and its legal equivalents for a complete statement of the invention.

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1-20 were rejected under 35 U.S.C. § 101; 35 U.S.C. § 112, first and second paragraphs; and 35 U.S.C. § 102(b) as being anticipated by Hillier et al. (Introduction to Operations Research, 6^{th} edition).

7. ARGUMENT

§101 Rejection of Claims 1-20

Claims 1-20 were rejected under 35 USC § 101 in the Office Action mailed on January 30, 2006 because that Office Action contended that the claimed invention is directed to non-statutory subject matter. In its response, the Applicant traversed that rejection, but nevertheless amended the claims to recite that the claimed method, machine-accessible medium, and process are related to solving a scheduling problem in a particular business operation. Notwithstanding the Applicant's amendment, the Final Office Action continued to reject claims 1-20 under 35 USC § 101. The Applicant respectfully appeals this rejection.

The claimed invention is directed to statutory subject matter. The background of the present application sets forth the real world environment in which the claimed invention operates. It describes that operators of plants are faced with many different types of decisions as to what to make, when to satisfy customer demand, and how to optimize profits. It sets forth a real world operations problem of current methods being unable to solve planning and scheduling problems within a reasonable time, and if they do provide a solution, it may be a local maximum, and not the best or optimal solution. Still further, the solution may not even be feasible. To address these problems, the claimed invention, in an embodiment, recites a method of solving a "scheduling problem in a particular business operation," and then "determining whether a solution to the scheduling problem is optimal, feasible, or infeasible." For at least this reason, the claimed invention is directed to statutory subject matter.

It should also be noted that operators of manufacturing plants are intimately familiar with the variables and constraints associated with the operations of their plants, and are well able to set up quadratic equations to address such variables and constraints. Still further, each plant likely has different sets of variables and constraints, and the identification and selection of such are not a part of the invention. As preferred by the Patent Office, well known aspects are preferably not described in detail.

The Final Office Action states that while the claims recite that the solution is a schedule for a manufacturing process, the Final Office Action contends that the claims do not clarify how the mathematical operations are specifically adapted to yield a specific, substantial or credible

result in relation to the schedule for operating the manufacturing process. The Applicant respectfully disagrees. Claim 1 specifically sets forth how the equations are solved by applying a bound propagation process, a local linear bounding process, a local linearization process, and a global subdivision search. The other two independent claims, claims 6 and 12, recite substantially similar elements. Thus, not only does it specify how the equations are solved, it provides the additional utility of determining whether the solution is optimal, feasible or infeasible.

The Applicant further respectfully submits that the utility requirement does not require that the specific, substantial and credible utility be recited in the claims. MPEP § 2107 II. Additionally, there is no requirement that any mathematical operations recited in a claim be adapted to achieve a specific, substantial or credible result. It is the claims as a whole which must accomplish such a result. Clearly, a schedule for a plant is such a result.

The Applicant respectfully submits that the claims describe whether a solution to a scheduling problem of a particular business operation is optimal, feasible, or infeasible. As such, it is believed to overcome the rejection under 35 U.S.C. § 101. Just as the calculation of a share price in *State Street*[1] was a useful, concrete, and tangible result, the calculation of a solution to a scheduling problem in a particular business operation that can be applied to a multitude of businesses and industries, and the determination of whether that solution is optimal, feasible, or infeasible, is a useful, concrete, and tangible result. In fact, it is a useful, concrete, and tangible result that is crucial to making decisions in operating a plant to produce things, such as ice cream, as described in the background section of the application.

The Final Office Action states that in order for the invention to be concrete, the claimed invention must produce a result that is substantially repeatable or reproducible. It goes on to state that since every permutation of variables, relationships, and constraints may be very different, any solution would not be substantially repeatable or reproducible. The Applicant respectfully submits that as recited in claim 1, for a particular "operations problem comprising a scheduling problem in a particular business operation," a person of skill will know what

[1] *State Street Bank & Trust Co. v. Signature Financial Group, Inc.,* 149, F.3d, 1368, 1373, 47 USPQ2d 1596, 1601-02 (Fed. Cir. 1998).

variables, relationships, and constraints to use, and further will know what quadratic equations to construct. These variables, relationships, constraints, and quadratic equations will produce repeatable results for each particular situation. This is just as concrete as the calculation of a share price in *State Street,* for the calculation of a share price in *State Street* is repeatable and reproducible if, and only if, the same situation is analyzed and/or the same data is used in the calculation. If not, an entirely new share price results from the calculation. The Applicant respectfully submits that that is one of the advantages of both the calculation of the share price in *State Street* and the solution to the operations problem in the present application.

The analogy on page 2 in the Final Office Action regarding the making of a dessert is at best irrelevant, and at worst is misleading. There is a clear distinction, and perhaps no relationship, between a batch of ingredients and the ability of a person of skill to concoct an unnamed dessert, and the use of variables, relationships, and constraints in a scheduling problem, solving non-convex equations by applying a bound propagation process, a local linear bounding process, a local linearization process, and a global subdivision search, and determining whether a solution to the scheduling problem is optimal, feasible, or infeasible.

Lastly, the Final Office Action states on page 3 that no real world effect is produced by the claimed invention, and that a solution may be found for a schedule without actually putting the schedule into practice. The Applicant respectfully submits that a scheduling problem in a particular business operation is a real world effect. And the contention that a solution may be found for a schedule without putting the schedule into practice actually highlights one of the advantages of the present invention---that is, a solution may be found, but will indeed not be put into practice if that solution is infeasible.

Consequently, for at least the foregoing reasons, the Applicant respectfully submits that the rejection under 35 U.S.C. §101 should be reversed.

§112 Rejection of Claims 1-20

Claims 1-20 were rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement, and further rejected under 35 U.S.C. § 112, second paragraph,

as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The Applicant respectfully appeals these rejections.

As explained in detail in the written description of the present application, in an embodiment, the variables recited in the claims may represent qualities, quantities, timing, and the like. Moreover, specific examples of one or more embodiments are provided in excruciating detail in the specification.[2] As pointed out *supra,* the Applicant respectfully submits that the subject matter of the claims are most assuredly reproducible and repeatable for any particular business or manufacturing process. The Applicant further respectfully submits that one of skill in the art of business and/or operations management would, without undue experimentation, be able to select pertinent variables for their processes and apply them to the subject matter as disclosed in the present application.

The Applicant therefore respectfully requests the reversal of the rejection of the claims under 35 USC § 112, first paragraph.

Regarding the rejection under 35 USC § 112, second paragraph, the Office Action states that the variables, relationships, and constraints of claims 1-20 are not explicitly defined. The Applicant respectfully disagrees. The specification states that in an embodiment, the variables may represent qualities, quantities, timing, and the like. The Applicant respectfully submits that a person of skill in business operations and/or manufacturing operations would be able to identify the variables that are pertinent to his or her industry (such as the quantity of oil in a tank in an oil refinery), and further would be able to use such variables and values in connection with the present disclosure.

The Applicant therefore respectfully requests the reversal of the rejection of the claims under 35 USC § 112, second paragraph.

§102 Rejection of Claims 1-20

Claims 1-20 were rejected under 35 U.S.C. § 102(b) as being anticipated by Hillier et al. (Introduction to Operations Research (6th ed)). The Applicant respectfully appeals this rejection.

[2] Specification, pp. 13-42.

Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration. *Verdegaal Bros. v. Union Oil Co. of California,* 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). It is not enough, however, that the prior art reference discloses all the claimed elements in isolation. Rather, "[a]nticipation requires the presence in a single prior reference disclosure of each and every element of the claimed invention, *arranged as in the claim." Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co.*, 730 F.2d 1452, 221 USPQ 481, 485 (Fed. Cir. 1984) (citing *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 220 USPQ 193 (Fed. Cir. 1983)) (*emphasis added*). "The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989); MPEP § 2131.

Moreover, whenever a claim is rejected, the ground of the rejection should be fully and clearly stated. Furthermore, an omnibus rejection of the claims is not informative.[3]

In rejecting the claims under 35 U.S.C. § 102(b) in the Office Action of January 30, 2006, the Office Action cited the entirety of Hillier et al., and in particular the table of contents, the index, and chapters 2, 3, and 13. In response, the Applicant stated that that rejection did not state the grounds thereof fully and clearly, and furthermore amounted to an omnibus rejection. In response to the Applicant's contentions, the Final Office Action states that Hillier discusses a general approach for determining whether the solutions of a model are feasible or infeasible, that the goal is an optimal solution, and that Hillier applies an analysis to a specific scheduling problem to find an optimal solution.

Notwithstanding the accuracy or inaccuracy of the Final Office Action's interpretation of Hillier, the Final Office Action fails to identify where in Hillier elements of claim 1 are disclosed such as forming non-convex quadratic equations and solving the non-convex quadratic equations by applying a bound propagation process, a local linear bounding process, a local linearization process, and a global subdivision search. These same elements, or substantially similar elements, are also recited in claims 6 and 12. Additionally, regarding claims 6 and 12, the Final Office Action fails to explain where Hillier discloses the element reciting that upon failing to find a solution to the scheduling problem, that a global subdivision search is applied to a

[3] MPEP § 707.07(d).

bounding region to produce two or more regions, and furthermore that the bound propagation, local linear bounding, and local linearization processes are iteratively applied to each of the two or more regions until it is determined that the solution to the scheduling problem is optimal, feasible, or infeasible.

Consequently, a *prima facie* case of anticipation has not been established, and the Applicant respectfully submits that the rejection under 35 U.S.C. § 102(b) should be reversed.

8. SUMMARY

For the reasons argued above, claims 1-20 were not properly rejected under § 102(b) as being unpatentable over Hiller.

It is respectfully submitted that the art cited does not render the claims anticipated and that the claims are patentable over the cited art. Reversal of the rejection and allowance of the pending claims are respectfully requested.

Respectfully submitted,

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Date December 19 2006 By

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Dawn M. Poole
Name

Signature

CLAIMS APPENDIX

1. A method of solving an operations problem, the operations_problem comprising a scheduling problem in a particular business operation,_comprising:

receiving variables, relationships, and constraints relating to the scheduling problem;

forming a set of non-convex quadratic equations based on the variables, relationships, and constraints;

solving the set of non-convex quadratic equations by applying a bound propagation process, a local linear bounding process, a local linearization process, and a global subdivision search; and

determining whether a solution to the scheduling problem is optimal, feasible, or infeasible.

2. The method of claim 1, wherein the solution is a schedule for a manufacturing process.

3. The method of claim 2, wherein the solution is a schedule for operating an oil refinery.

4. The method of claim 1, wherein the solution is a plan for a manufacturing process.

5. The method of claim 4, wherein the solution is a plan for operating an oil refinery.

6. A machine-accessible medium having associated content capable of directing the machine to perform a method of solving a set of non-convex quadratic equations relating to a scheduling problem in a particular business operation, the method comprising:

selecting a region bounding all variables relating to the scheduling problem;

applying a bound propagation process to the region to refine the bounds and improve linearization;

applying a local linear bounding process to the region to determine feasibility and to find approximately feasible solutions to the scheduling problem;

applying a local linearization process to the region to determine feasibility and local optimality;

upon finding an optimal global solution to the scheduling problem, providing the optimal global solution and information indicating optimality;

upon finding a feasible global solution to the scheduling problem, providing the feasible global solution to the scheduling problem and information indicating feasibility;

upon determining local infeasibility, eliminating the region from consideration;

upon determining global infeasibility, providing information indicating infeasibility; and

upon not finding a solution to the scheduling problem, applying a global subdivision search to the region to produce two or more regions and iteratively applying the bound propagation, local linear bounding, and local linearization processes to each of the two or more regions, until determining the solution to the scheduling problem is optimal, feasible, or infeasible.

7. The machine-accessible medium as recited in claim 6, further comprising:
receiving input variables, constraints, and equations.

8. The machine-accessible medium as recited in claim 6, further comprising:
receiving a measure of optimality used to determine the global optimal solution.

9. The machine-accessible medium as recited in claim 6, further comprising:
receiving a measure of feasibility used to determine the global feasible solution.

10. The machine-accessible medium as recited in claim 6, further comprising:
providing a schedule for operating a plant.

11. The machine-accessible medium as recited in claim 6, further comprising:
providing a plan for operating a plant.

12. A process of solving a set of non-convex quadratic equations relating to a scheduling problem in a particular business operation, comprising:

selecting a region bounding all variables relating to the scheduling problem;

applying a bound propagation process to the region to refine the bounds and improve linearization;

applying a local linear bounding process to the region to determine feasibility and to find approximately feasible solutions to the scheduling problem;

applying a local linearization process to the region to determine feasibility and local optimality;

upon finding a solution to the scheduling problem after the local linearization process, providing the solution;

upon determining infeasibility, eliminating the region from consideration; and

upon not finding the solution to the scheduling problem after the local linearization process, applying a global subdivision search to the region to produce two or more regions and iteratively applying the bound propagation, local linear bounding, and local linearization processes to each of the two or more regions, until determining the solution to the scheduling problem is optimal, feasible, or infeasible.

13. The process as recited in claim 12, wherein the local linearization process is the local linear bounding process.

14. The process as recited in claim 12, wherein the local linear bounding process comprises:

performing differentiation on equations in the region;

determining lower and upper bounds on the variables in the region;

applying a linear programming process to the linear equations in the region;

determining whether a solution exists in the region;

upon finding a solution exists, determining local feasibility; and

upon finding local infeasibility, determining global infeasibility.

15. The process as recited in claim 12, wherein the local linearization process comprises:

performing differentiation at a point in the bounded region;

forming a set of linear equations;

applying a linear programming process to the linear equations in the bounded region; and

generating a new point in the bounded region and repeating the local linearization process with the new point.

16. The process as recited in claim 12, wherein applying a global subdivision search to the region to produce two or more regions comprises:

maintaining a list of non-closed nodes;

selecting a candidate set of nodes from the list;

selecting a chosen node from the candidate set;

subdividing a point range of the chosen node;

closing the chosen node; and

opening two new nodes that subdivide the chosen node.

17. The process as recited in claim 16, wherein selecting the candidate set of nodes is done by selecting linearized nodes.

18. The process as recited in claim 16, wherein selecting the candidate set of nodes is done by expanding nodes that have not yet been partially expanded.

19. The process as recited in claim 16, wherein selecting the candidate set of nodes is done by selecting expanded nodes.

20. The process as recited in claim 16, wherein subdividing the two new nodes that subdivide the chosen node comprises:

subdividing a point range;

upon determining the chosen node is linearized and divergent, computing a worst divergence; and

upon determining the chosen node is not linearized, computing a dimension of largest infeasibility.

EVIDENCE APPENDIX

None.

RELATED PROCEEDINGS APPENDIX

None.